

Colloquium

Hunt and Peek

Scientists track down how much global-warming carbon dioxide a forest can absorb



eight ball in the side pocket. Fellow hunter-gatherer Smith scribbles notes on a brown paper bag that will hold their quarry. Ollinger aims, shoots and scores. Through a haze of blue-gray smoke, splintered branches and leaves peppered with bullet holes flutter 70 feet down from the crown of the tall red maple tree that Ollinger, a UNH research assistant professor, has just bagged as part of a national climate change research effort called the North American Carbon Program. The hills are alive with the sound of science.

What would appear to be fieldwork in the style of John James Audubon or Charles Darwin is, in fact, cutting-edge stuff. That's because, while Ollinger, Martin, also a UNH research assistant professor, and Smith, a research ecologist with the U.S. Department of Agriculture's Forest Service, surgically remove leaves using 12-gauge

ison, the instrument aboard the Landsat 1 satellite that gave us our first remote glimpse of Earth in the early 70s created images using a mere seven spectral bands.

What Ollinger and company are composing is a large-scale picture of forest productivity in the White Mountains, using the combined data gathered from a chemical analysis of top-layer tree leaves and spectral images from AVIRIS. The ultimate goal of the research is to determine just how much carbon and nitrogen are being released and stored by this big chunk of woodland and beyond, information that is critical to understanding, and dealing with, climate change and global warming.

Over the last few years, the scientists have shot leaves and spectral images from New England to the Catskills, from Florida to New

BACKGROUND PHOTOGRAPH BY JIM ROSS/NASA

It is mid-August in New Hampshire's White Mountains, and Scott Ollinger '92G, '00G, Mary Martin '88, '94G and Marie-Louise "M.L." Smith '00G, shotguns in hand, are stalking *Acer rubrum* on Plot 32-P of the 2,600-acre Bartlett Experimental Forest. The crack of distant gunfire cuts through the air and fades away. Here on 32-P, Ollinger looks skyward, squints down the length of the barrel, and yells out "Another maple!" much the way a pool player announces the intention of putting the

steel birdshot, a modified U2 spy plane hurtles through near-space, 70,000 feet up in the stratosphere, doing some shooting of its own.

The high-flying NASA ER-2 Airborne Science plane photographs the canopies of 32-P's trees with a "hyperspectral" instrument called AVIRIS, short for Airborne Visible-Infrared Imaging Spectrometer. AVIRIS uses a whopping 242 bands of visible and infrared light to "read" the chemical content of leaves. By compar-

South Wales, Australia, honing the technique and gathering data.

Carbon, the stuff of life, is a key player in one of Earth's biogeochemical cycles, along with the interwoven nitrogen and water cycles. Because carbon dioxide in the atmosphere drives the whole process of climate change, "It was recognized early on that we need to know how carbon is released and stored,"





says Ollinger, who specializes in forest ecosystems and remote sensing at UNH's Institute for the Study of Earth, Oceans, and Space. Some of the carbon dioxide emitted by human activity gets absorbed by the oceans, some by plants. The rest stays in the atmosphere.

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Shooting leaves and hyperspectral images and comparing their data is one means of getting good numbers. It is also a method that gets the biggest bang for the buck. The chemical and spectral data from a series of 20-by-20-meter plots (the same area as one AVIRIS pixel), combined with annual growth measurements of trees in those plots, provides the scientists with information about forest productivity that can be ap-

plied to a much larger region, in this case the entire White Mountain National Forest. In its simplest terms, the research Ollinger, Martin (who pioneered the method of correlating leaf chemistry with hyperspectral images) and Smith are doing determines the level of nitrogen in leaves shot from the tops of trees on a specific plot of forest. (Nitrogen is typically the limiting nutrient with respect to plant growth; the more there is the more growth occurs.) This is then correlated with the AVIRIS im-

ages, which also identify leaf nitrogen content depending on how light is absorbed or reflected by the leaf surface. With this data for one plot, and after shooting and analyzing similar plots with a wide variety of trees having both high and low nitrogen content, the scientists can accurately gauge just how much nitrogen is in all the trees for a whole forest. The process gives them overall forest productivity or, put another way, how much carbon has been added to the trees.

Says Ollinger, "Wood production tells us a lot about carbon uptake because wood is about 50 percent carbon." He adds, "The fact

that canopy nitrogen is so tightly correlated with growth rates means that if a pixel on our AVIRIS image represents a foliar nitrogen value of two percent, we know that about 2,650 pounds of carbon or 5,300 pounds of new plant biomass is added per acre annually." For a time, at least. As trees mature, their growth rate slows down and, eventually, the carbon in matches the carbon out. Thus, forests are not an infinite "sink" for atmospheric carbon.

Although this scientific marriage of low and high technology is young, Ollinger notes, "We've more than scratched the surface of what we can do with this kind of technique. But we have not investigated all possibilities."

Ollinger's pie-in-the-sky goal would be to shoot the North American continent in an effort to get a clearer picture of the continental carbon cycle. If NASA gives a thumbs-up to the research team's next renewal proposal, which will include 10 new sites strategically located around the country, Ollinger may have a piece of his pie sooner rather than later.

—David Sims